

The impact of Fablab Enschede on applied research.

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ABSTRACT

At FabLab Enschede, the Netherlands, we meet different users everyday. These users – creative people and artists, volunteers, employees of SME's and big firms and, since we are located within Saxion University of Applied Sciences, lots of students– share ideas and make use of our equipment. Regularly new technical possibilities or materials are discussed and experimented with, just for fun or out of curiosity.

Researchers of the Saxion Research group Design & Technology also frequently use FabLab Enschede. They see interesting things happen in the FabLab with research projects as a result. Small-scale experiments with casting slip and initial trials of 3D printing on textiles lead to the major research project “Breakthrough in 3D printing”, a 2 years TechForFuture program that involved over 100 technical, design and business students, 7 Saxion research groups and 18 companies.

FabLab Enschede also profits of these research projects as they bring new knowledge and new 3D printers to the FabLab as part of the experimental research that is done. This way, FabLab has not only impact on the applied research, but has research projects also impact on the FabLab.

KEYWORDS

Applied Research, small-scale experiments, 3D concrete printing, 3D printing on textiles

INTRODUCTION – FABLAB ENSCHEDE

FabLab Enschede started in 2011, being the fourth FabLab in the Netherlands. Saxion University of Applied Science (UAS) and additional financial support of local and regional government made it possible to build a public FabLab with high-end machinery. FabLab Enschede focuses on High Tech, Smart and Textile, three important topics for the Enschede region. Local industry and research centres join forces in de field of High Tech Systems and Materials, and Enschede is famous in the Netherlands for its Textile industry and education.

In FabLab Enschede artists, SME's, starters & large companies and individual makers make use of its facilities side by side with lecturers, students and researchers who are actively involved in education projects and applied research of Saxion UAS.

In order to meet the specific needs of the different users, purchase of the high-end machinery in the FabLab has been carefully planned in dialogue with the user groups, amongst others, with the members of the Saxion research group Design & Technology.

Another important user group of the lab is the FabLab team. The passionate team distinguishes itself within the UAS because of its mix of staff, assisting students and volunteers. Especially the volunteers play an important role. They invest their time to conduct experiments and build projects to develop, test and share knowledge. Volunteers support the staff by exploring and experimenting with topics of their own interest and potentially interesting to the FabLab. Experiments often relate to optimizing and maximizing the use of the machinery and materials at hand or building on knowledge and inspiring projects from the FabLab and maker community.

The small scale experiments and projects presented by the FabLab users often inspire others to apply different technology, materials or solutions to their own work. Results from experiments with open source 3D printers inspire researchers to build a large research project.

FABLAB AND APPLIED RESEARCH

Although positioned and acting as a public workspace, FabLab Enschede is linked to the Research group Design & Technology [1] and the School of Life Science, Engineering & Design (LED) of Saxion UAS [2]. The Saxion Research group Design & Technology consist of specialist researchers in the field of Industrial Design, Nanotechnology, Smart Functional Materials, Light Weight Structures and Ambient Intelligence. The aim of the Research group is to develop knowledge of interest for, and in close cooperation with, companies, students and lecturers to make the transition of academic research to pragmatic solutions, useful for the professional practise.

Of course, FabLab is not the only lab or workspace within Saxion. Different research groups have specialized research labs. Available to LED students are, among others, a well-equipped woodshop, metal shop, chemical and Nano lab. However, these workshops and labs are usually focused on one type of subject or student and limited to Saxion use only. The difference with FabLab is that it's open to anyone and that knowledge is shared between its users, therefore creating a melting pot of people with different backgrounds, scopes and ideas. This abundance of creativity and experimenting, combined with the access to the equipment, makes crossovers between fields of expertise more likely.

Seen from applied research perspective, the FabLab is an additional facility with capacity and other knowledge that can be accessed by the research groups when needed. Certain research and prototyping is assisted by or even outsourced to the FabLab team. This access to innovative thinking and equipment beyond their regular staff and means offers the research groups flexibility, new insights and a strong advantage.

Simultaneously, the FabLab is provided with continuous questions, tasks and requests for prototypes by the research groups and in this way offering the FabLab team an interesting podium to shine by adding value to applied research.

FROM FABLAB SMALL SCALE EXPERIMENTS.....

Vital in motivating and inspiring users to work with the machinery at the FabLab is to show tangible examples of the many possibilities. Combined with the staff's ambition and curiosity to master the machines beyond limits, this has led to (ongoing) small scale experiments with the different machines available like, amongst others, the laser cutter, vinyl cutter, embroidery machine and various 3D printers. FabLab Enschede has a wide range of 3D printers with open source and low budget printers, such as an Ultimaker 1, Printrbot, Prusa i3 and Up and more accurate and expensive printers such as a Dimension 1200SST and an Objet 30 Scholar.

Especially the knowledge on and access to 3D printers at the FabLab proves to be complementary to the existing infrastructure of Saxion UAS and adds a strong added value for both for education purposes as well as conducting research. Research groups follow with great interest the 3D print experiments conducted by the FabLab team.

3D printing with Concrete, Plaster and Casting Slip

Inspired amongst others by projects of Enrico Dini, who uses 3D printing to construct buildings, FabLab Enschede started experiments on its Ultimaker 1, an open source 3D printer, to 3D print simple shapes in concrete, plaster and casting slip. In order to do so, some alterations were made to the printer. To make use of the driver software and printer platform, a tube was mounted to the print head to add the alternative materials, thereby bypassing the filament extruder, hot end and nozzle.

Experiments with different materials resulted in first-hand experience. The small scale experiments started by using concrete, then switched to plaster and finally to casting slip with some interesting and satisfying results.

3D Printing with regular concrete proved to be quite a challenge. The concrete was not solid enough, so adding layers on top of each other made the printed object sink in. Further research into suitable concrete mixtures was required.

3D Printing with plaster proved to be more successful for the first printed layers. With the plaster solidifying quickly during the printing process, the difficulty was to print the last layers of an object in good quality, see figure 1.

Based on the experiments with concrete and plaster, a more consistent material was tested: casting slip. Casting slip solidifies slowly in the course of hours and the viscosity can be altered in a rather controlled way. This made it a very suitable material to make some successful test prints, i.e. objects with a consistent quality in all printed layers.



Figure 1: 3D print sample in plaster

3D printing on different base materials

Other small experiments focussed on the bonding between different materials when one material is applied by 3D printing on a surface of other material. Different materials have been used to print on, such as various types of textile, BioPreg (a thermoplastic with natural fibres) and recycled fabrics. In figure 2, the base on which is printed consists of old flight crew uniforms. The materials used as printing filament were: ABS, PLA and PU. These experiments have been scaled up, as part of a larger research program to see if the bonding of 3D printed material is strong enough for practical use.

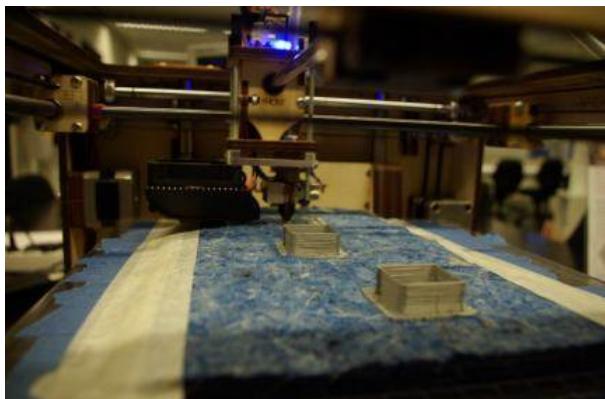


Figure 2 – 3D printing on a base of textile

.....TO APPLIED RESEARCH PROJECT

In 2013 the Saxion Research group Industrial Design acquired a TechForFuture grant for a project called “Breakthrough in 3D printing”. TechForFuture [3] is the HTSM Centre of Expertise for the Eastern Netherlands region. This two-year research project addresses a range of materials and their 3D printing potential, properties and design rules, required platforms and hardware, promising applications in a range of markets, and involves over 100 students of different backgrounds (design, engineering and business), 18 SME’s and large companies, 7 Research groups of 2 Universities of Applied Sciences (Saxion and Windesheim).

Five work packages cover a wide range of subjects like high-performance photopolymer plastics for nano/micro housing, FDM printing of ceramic products, personalized health

products, design rules and comparison traditional and 3d printing production processes and legal issues like liability and IP.

Each subproject has its own and specific interaction with FabLab Enschede. This paper examines two cases in more detail.

Case 1. From small-scale experiments with molding clay to the development of a 3D concrete printer demonstrator.

Experiments in the FabLab in 2012 have demonstrated that it is possible to print high-viscous materials like molding clay and plaster. Information came available of interesting experiments at Loughborough University (UK) [4] and Contour Crafting of University of Southern California [5]. Also DUS Architect showed their first pictures of a 3D printed (plastic) CanalHouse in Amsterdam.



Figure 3 – The concrete bench of Loughborough University (2010)

Figure 4 – Contour Crafting University of Southern California

But how realistic were these ideas? The excitement about the first experiments in the FabLab resulted in a project starting September 2013 of which the goal was “to realize a demonstrator to proof that 3D printing in building construction is realistic”. Questions to address were, among others: Which concrete mixes give the best results? How can reinforcement be incorporated? What dimensions and configurations are possible? What are useful applications of 3D concrete printing for Dutch housing? Does it lead to smart, lightweight construction materials and innovative structures and designs? And not to forget: Will it be an interesting enough research projects for 2 years of students on a row.

The first student started in a corner of the Fablab building a X-Y-Z-table using an existing frame. But very soon it became clear that further research was needed. That is where the Research group together with students of Saxion came in.

During three consecutive semesters, groups of students of different backgrounds worked close together. Chemical students together with industrial partners developed the recipe of 3d printable concrete. Two groups of mechatronic students worked in competition on a printing-platform; mechanical engineering students with industrial design students designed the head and material supply, and students of computer sciences developed the software. Not only engineering students were involved: Business students made a survey of interesting applications for the Dutch building market. Also an industrial design student graduated on the design of the demonstrator: a pedestal for a statue.



Figure 5 – Saxion students on initial concrete printing trials

Researchers contributed with their research and by coaching students. A consortium of partners consisting of architectural office and building contractors and building materials suppliers contributed with their knowledge and testing facilities.

The results are promising: The small scale 3D concrete printing equipment and the demonstrator are so interesting, that the partners want to facilitate a new project to scale things up. But they have to speed up: in the mean time a Chinese firm WinSun Decoration Design Engineering showed it is possible to print houses [6].

This project provided FabLab Enschede the opportunity to expand its expertise on 3D printing of extraordinary materials and made part of the knowledge gained available for all users.

Case 2. 3D printing on textiles.

As described earlier, initial trials showed it was possible to print on textile. But how does that change the properties of the textile? How does the bonding of the printed material react on wearing and sweating? What is the effect of washing the cloth in a washing machine? Researchers and students of the research group Smart Functional Materials (SFM) addressed these and other questions as part of the TFF-project and a major research program on smart textiles of SFM. The final goal is to develop a printing process for direct application of conductive polymers on textiles. The major challenge is to fit the process of printing conductive tracks in the production chain of textiles for high-end applications like fire suits. However, a lot of testing needs to be done first. Different polymers are printed on various textile substance compositions to determine good bonding matches. For this purpose the research group SFM acquired a special Cartesio 3D printer, which was housed in the FabLab. In this way the 3D print knowledge of the FabLab people was shared and visa versa. Also specialized testing equipment like a textile long term bending machine was developed and made using the facilities of the FabLab.

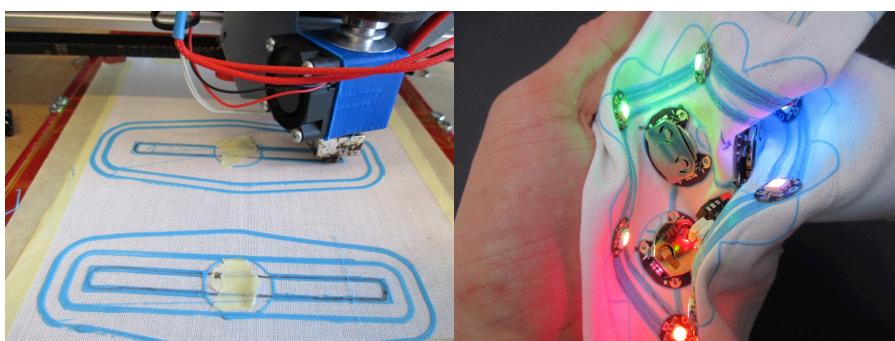


Figure 6 – Saxion/SFM 3D printing of conductive polymers on textiles

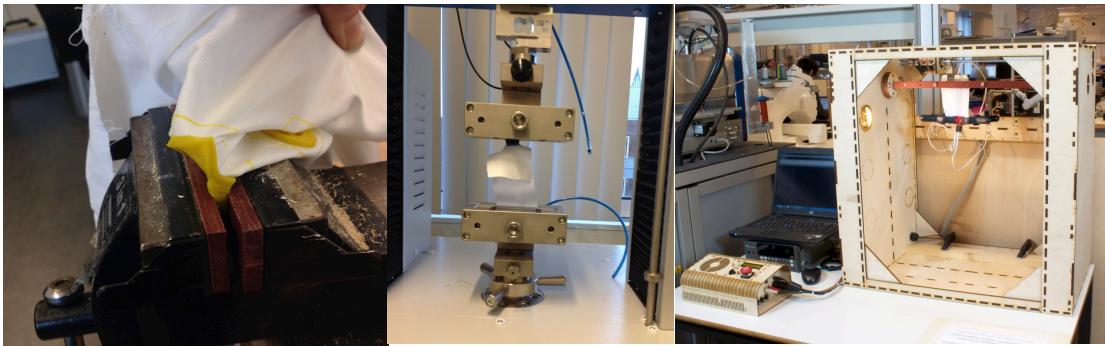


Figure 7 – Bonding tests of 3D printed material on textiles. Devices made in FabLab

IMPACT FABLAB ON APPLIED RESEARCH AND VISA VERSA

The interest raised by FabLab among research groups to conduct further research on applying 3D printing in different industries, gave FabLab the opportunity to be part of a larger project and have new knowledge and equipment. FabLab got additional training on 3D printing from the industry, a trial licence of the professional software Magics and new 3d printers in the lab, such as a Form 1 plus. Collaboration with the different research groups, including business development, provided knowledge on Intellectual property and legislation concerning 3D printing. By actively contributing to the project, all the participating researchers and companies involved have become more aware of the possibilities within FabLab and the added value for their business.

On management level this research project has made a lot of impact, being able to show an appealing hands-on demonstrator to its (political) network on how small scale experiments have led to a large scale project with many different partners involved.

New projects with further research on 3D printing are about to start. Very exciting is the 3D metal printer, which will be operating this September at Saxion UAS both for research and education purposes and with FabLab Enschede being one of the project-partners.



Figure 8: 3D concrete printer and samples of tested concrete presented to Minister of Economic Affairs

REFLECTION

Although the mutual benefits are becoming clear to all, there are also contradictions. The potential tension between the openness of a Fablab and the more normal culture of secrecy of research needs attention. Especially when IP is at stake, the two worlds not automatically match. When people of different background work together in a open atmosphere as FabLab it is not always clear whose idea it was.

But there are more differences in worlds to be bridged. FabLabs usually has this aura of slightly chaos and contingency, which can easily interpreted by some as not serious. Some scientists on the other hand want us to believe that their achievements are the result of the systematic approach only. This can lead in the extreme to the situation of misunderstanding and worse.

What we also sometimes see is that 3d equipment is purchased for educational reasons and put in a classroom, so they don't have to share it. But those 3d printers are not frequently used and operated by teachers who lack detailed knowledge of the process, with the risk that the equipment is hardly used and end up in the FabLab.

Mutual understanding of each other, regular consultation and appropriate agreements are needed to avoid above undesirable situations.

CONCLUSIONS

After being in operation now for four years it is clear that applied research of Saxion UAS benefits of FabLab Enschede next door, and the other way around. FabLab Enschede has impact on applied research through its initial experiments, participants of different backgrounds responsible for crossovers and through its well-equipped workshop with innovative people.

But also the other way around: applied research brings new knowledge and new equipment to FabLab which otherwise could never be afforded.

Acknowledgement

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